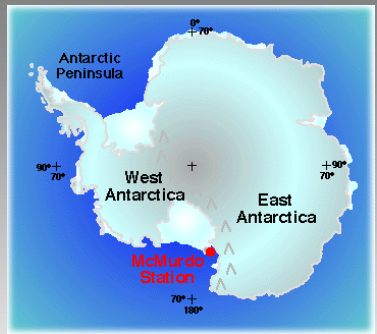
The Polar Ice Sheet Rover



Alberto Behar, Ph.D.
Robotic Vehicles Group
Jet Propulsion Laboratory
Pasadena, California, USA

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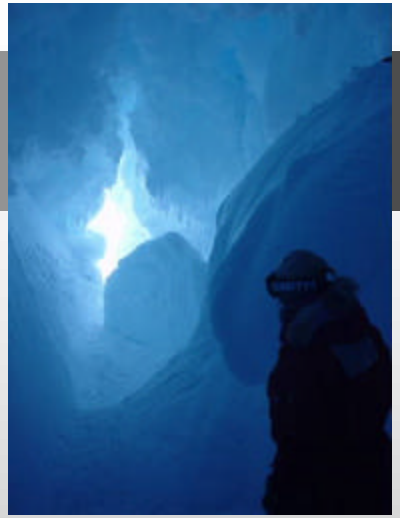

- **Description**
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Project Description

- **Tumbleweed will send two side-looking color images, GPS location, temperature and pressure data every 15 minutes for the entire approximately four-day travel from the South Pole to the coast.**
- **This test will confirm the viability of using inflatable devices for both the Tumbleweed and the Inflatable Rover.**
- **Ultra-strong Spectra is a material that has been proposed for Mars inflatable applications, and this test will confirm its long-term durability in a cold environment.**
- **These rolling tests will also be a major boost for Tumbleweed applications at other solar system locations including Venus, Titan, Io, and Triton, and for Inflatable Rover applications on all the solid planets and moons in our solar system.**
- **This test will also enable future Earth Science Tumbleweed missions to the Arctic and Antarctic regions to measure ice thickness & temperature (global warming), increase the amount of topographical data (currently minimal at the south pole), measure ground UV intensities (ozone depletion), and search for possible subsurface meteorites (radar and magnetometry).**

Project Description

- **Tumbleweed consists of:**
  - **Electronics package suspended in inflated bag;**
  - **Bag is 2 layers, one of nylon and one of polypropylene;**
  - **Total mass less is than 12 kg;**
  - **3 m inflated; inflation with air takes 15 minutes;**
  - **Acquires and transmits images, GPS, temp, pressure data en route;**
  - **No capability to control direction of motion;**
  - **No fuel or toxic materials but does have battery on board;**
  - **Speed estimated at 5 m/s, minimum wind for movement is 2 m/s.**
  - **Tumbleweed is transported on flight of opportunity deployment site, inflated, powered up, checked for communications link, and released;**
  - **Progress of Tumbleweed is monitored from JPL as well as any internet access point**
  - **Various versions of this concept have been proposed in the past (U.S. and France)**

Project Sponsors

- **Previously NASA - Code R, Technology Office**
- **Jet Propulsion Laboratory**
  - **Div. 34, Mobility Systems Section**
  - **Div. 35, Mechanical Systems Engineering & Research**
  - **Director's Discretionary Fund – Current Proposal**
- **Funding Sought from NASA Code Y - Earth Sciences & Code S - Space Sciences**
- **NSF (Deployment Logistics)**
  - **Office of Polar Programs**

Project Team

- **Project Name**
  - **Technology Development for Advanced Mobility Concepts**
- **Project Team**
  - **Jack Jones, Mechanical Systems Engineering & Research**
  - **Frank Carsey, Earth & Space Science Division**
  - **Alberto Behar, Avionic Systems & Technology Division**
  - **Brian Stone, National Science Foundation, Office of Polar Programs**

Scientific Objectives

Main Objective:

First test - determine topography of route

Locations:

- Have considered Greenland, South Pole, Siple Dome, and Dome C, all seem workable

- Other sites as available

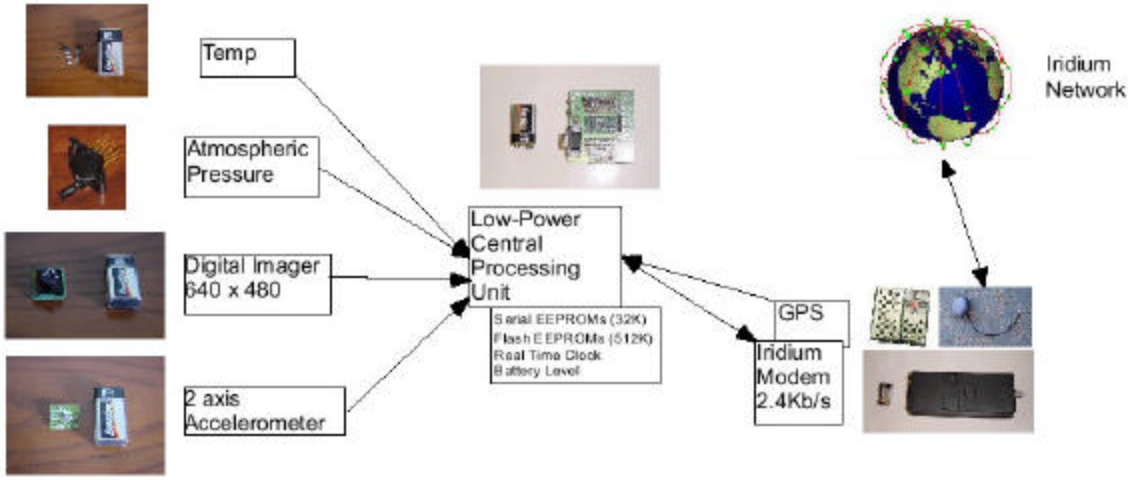
Technology Objectives

- **Stepping stone in the development of technology to acquire science data in remote, extreme ice environments**
- **Demonstration of Tumbleweed in conditions similar to Mars midlatitude summer**
- **Demonstration of technology of scientific use for current Earth Science interests in Antarctica**
- **In future, missions can use technology developed for:**
  - Mars, Venus, Io, Triton, etc.

Rover Specifics

Antarctic Tumbleweed System

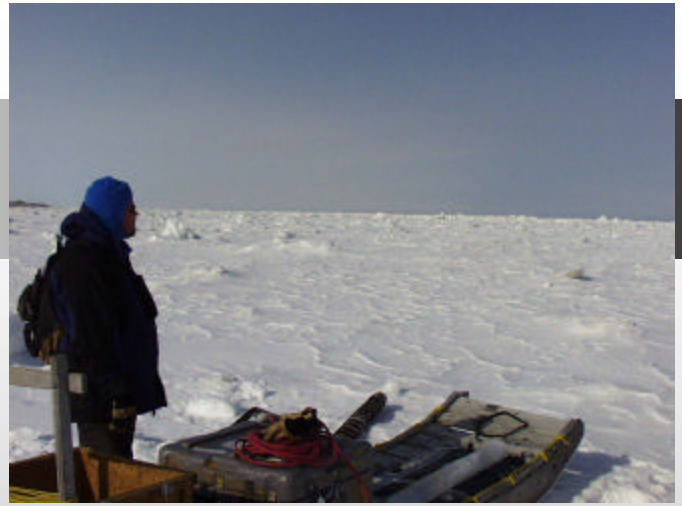
Specs:
- Diameter: 2 meters
- Total Mass: ~20 kg
- Power: ~ 10 watts (active)
- Energy: ~500W watt/hr
- Lifetime: ~96 hours
- Temp: -40 C to +40 C
- Uplink: 4 times/hour



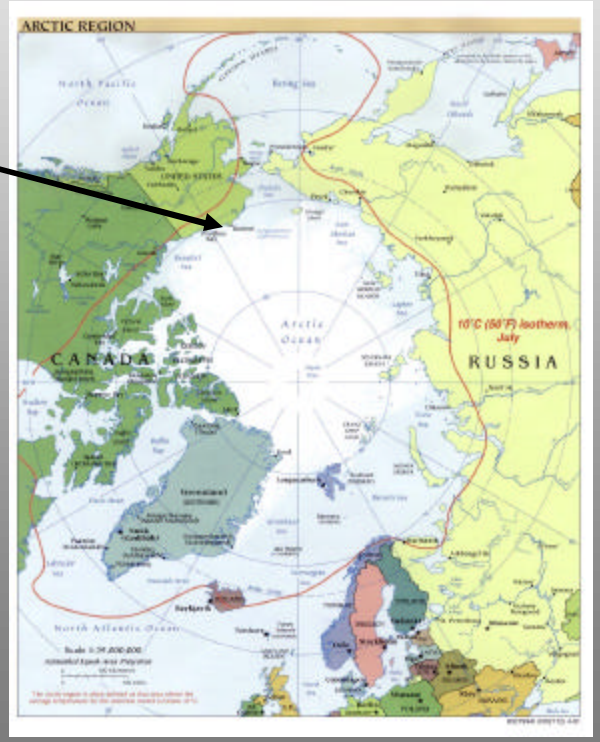
Field Tests

- **Consists of:**
  - **Wind and Stability Testing, Mojave Desert**
  - **Rolling Iridium Comm. and GPS Testing, Pasadena, CA**
  - **Material Compatibility and Integration Testing, Pasadena, CA**

Recent Tests



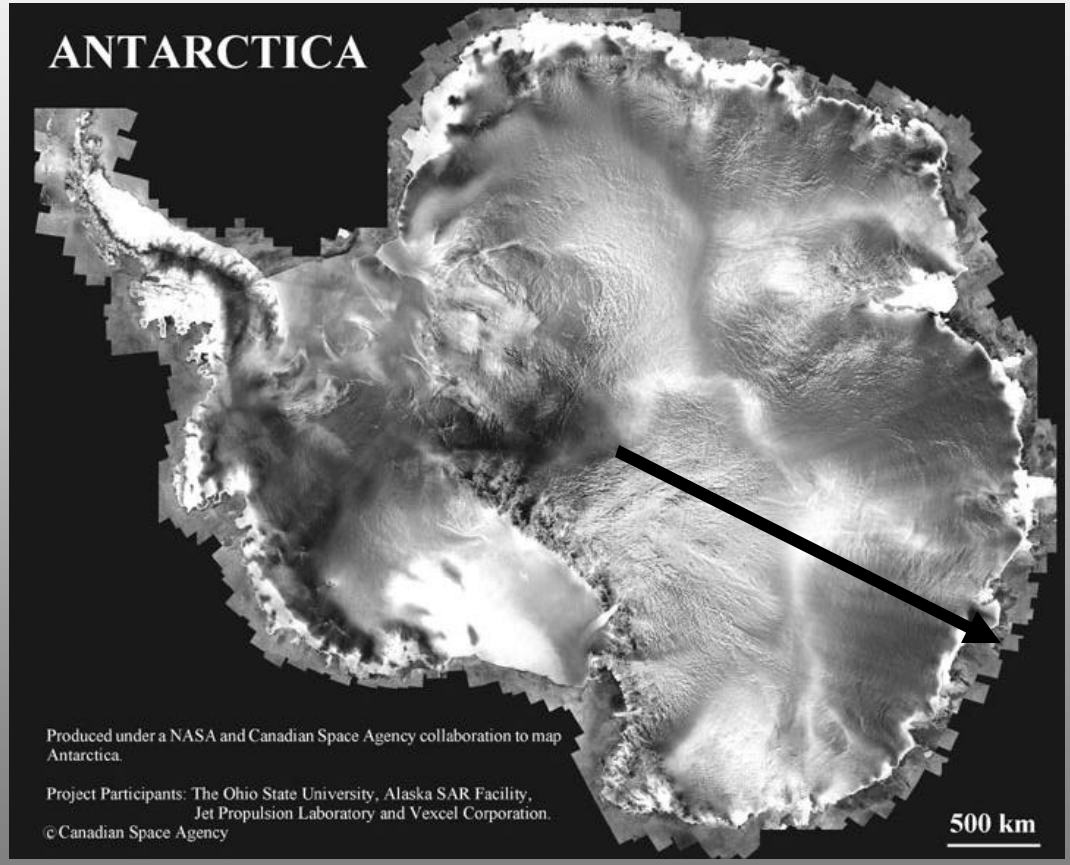
- **Mid November 2002**
- **Barrow, Alaska**
- **Focus:**
  - **Rolling Comm./GPS**
  - **Temperature Survivability**



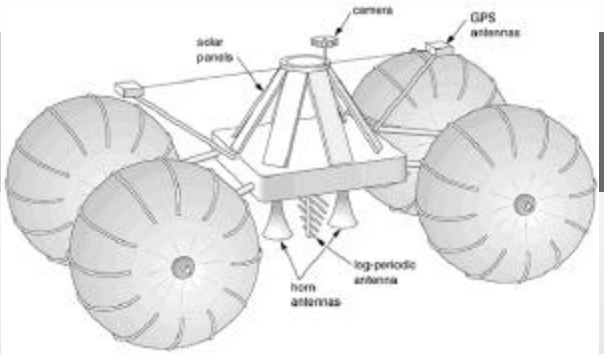
- **See:**
  - **robotics.jpl.nasa.gov/~behar/JPLTumbleweed.html**

South Pole Deployment – 03/04

- **Test Range: 200km minimum**
- **Duration of Test: 1-10 days**
- **Scheduling of test: Any time during summer field season**
- **Equipment Retrieval not required by NASA/JPL**



Related Earth Applications



Sea-Ice Rover

- Goal of project to support accurate, broad-coverage, routine measurement of sea ice thickness.
- The objectives to achieve this goal are to:

  1. Develop a sea ice rover system capable of **long traverses** (1000 km), including deployment of instruments for **determination of ice thickness**, use of **solar power**, and **real-time data** transmission back

  2. Demonstrate the system in a sea ice environment characterized by **low logistical costs** and the presence of supporting environmental and calibration data.

  3. Provide the Earth science community with a **new technology** for making **long-range surveys** in hostile or difficult environments.

- Schedule:

  Year 1: System design and Hardware Development

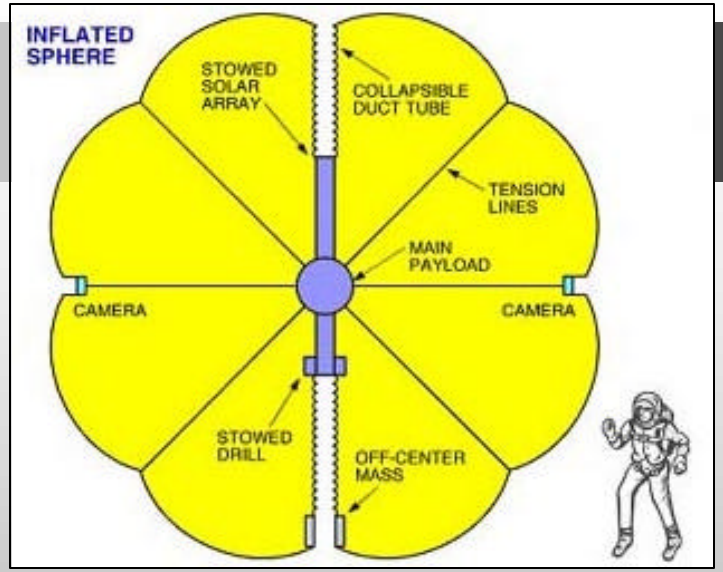
  Year 2: Initial Field Tests in relevant environments

  Year 3: Long Range Field test in extreme environment

Mars Concept

Mars wind-driven “Tumbleweed” balls can be used for:

- Descent (replace parachute)
- Landing (airbag)
- Mobility (wind-driven on surface)



A Central Payload is held by a Series of Support Lines in the Tumbleweed Ball

Future Applications

- **Concept can be used to explore:**
  - **Surfaces of Venus, Titan**
  - **Saturn's moon Io (supersonic volcanic wind)**
  - **Neptune's moon Triton (significant surface wind erosion)**

- **For Venus and Titan:**
  - **Used as super-pressure balloon with periodic descents to the surface**
  - **Brief venting of helium at altitude, causing descent**
  - **Dropping ballast or experiments on surface, causing ascent**

Current Status

- **Technology investigations for Tumbleweed are so far successful**
- **Polar investigations abound for this type of technology**
- **Further development needed in expanding sensor suite (radar, magnetometer, etc.) and support systems (electronics, batteries, etc.)**
- **We are open to collaborations to further develop and test these systems**

Fin!